COMP 9517

T1, 2020

Assignment 1: Specification

Maximum marks achievable: 10 marks

This assignment is **worth 10% of the total course marks**.

The assignment files should be submitted online.

Instructions for submission will be posted closer to the deadline.

Deadline for submission is week 4 Monday March 9th, 23:59:59

Deliverables: You will submit a report (maximum 5 pages) briefly explaining the approach you have taken in Tasks 1, 2 and 3 and include some sample input images and the intermediate and final images obtained. You must also submit the Python source code files.

Submission: The assignment files should be submitted online via WebCMS. Instructions for submission will be posted closer to the deadline.

Tip: You are advised to use OpenCV 3+ with python 3+. Jupyter notebook files are preferred as source files.

Objectives:

This assignment is aimed at familiarisation with basic image processing methods. It also introduces you to common image processing and analysis tasks using OpenCV. After completing this assignment, you will learn how to:

1. Open and read image files
2. Perform simple mathematical operations on images
3. Construct and manipulate image pyramids
4. Carry out translation-based alignment
5. Perform image adjustment and restoration

Task:

Sergei Prokudin-Gorsky (1863-1944) was a Russian photographer and chemist whose collection of colour photographs is the oldest surviving to this date. He used a camera that took a sequence of three black and white exposures using blue, red and green filters. By projecting the three images using colored light it was then possible to recover the original colours. See here for more details. At the beginning of the 20th century, Prokudin-Gorsky embarked on a multi-year project to systematically document the life of the Russian Empire by means of the new colour imaging technology. He then took many of the resulting negatives with him on emigration following the revolution of 1917 and they were eventually purchased and digitized by the US Library of Congress.

The objective of this assignment is to produce high quality colour reconstructions from

Prokudin-Gorsky's negatives using simple image processing techniques.

You will need to extract images for the individual colour channels, align them and form a single colour image. For this assignment, it is sufficient to use an x, y translation-based transform but feel free to implement other methods. You must use OpenCV with Python to complete this assignment.

Instructions:

Task 1 (4 marks)

Download the high-resolution negatives from Webcms3 (Course Work → Assessments → Assignment 1 → Assignment 1 Images (20T1)). Write a program that takes any one of these files as an input and produces a corresponding colour image as output. To do this you should divide the original image into three channels and then align the second and third channels to the first, displaying the resulting offsets for each channel.
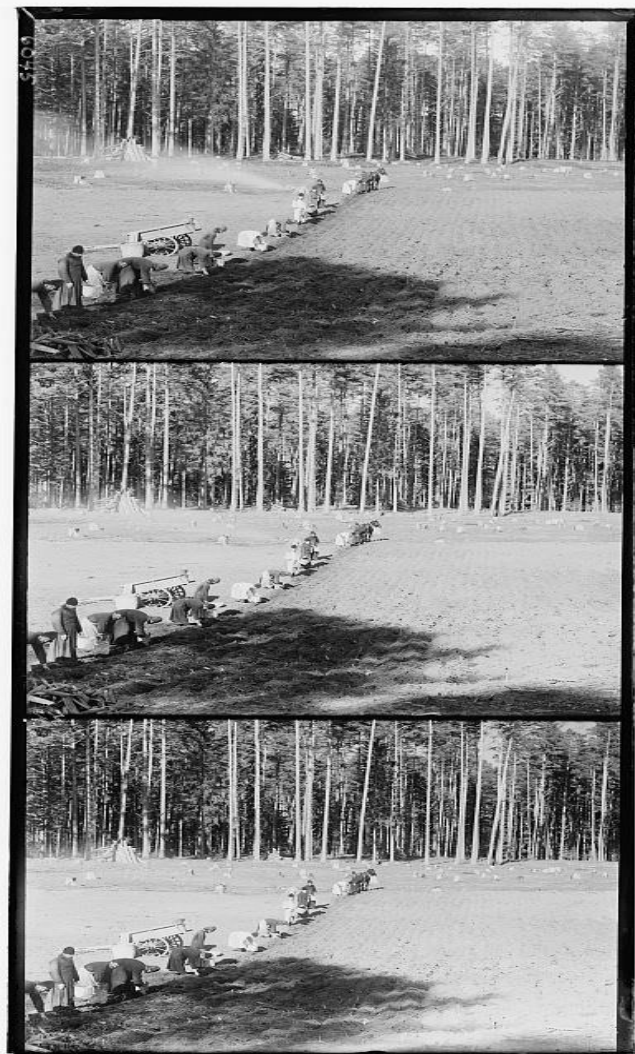
Figure 1: *High quality colour reconstruction example.*

A simple way to perform the alignment is by searching through all possible offsets in some suitable range (e.g. 20 pixels for low resolution images) and computing for each a score measuring the quality of the match. Three suitable metrics include sum of squared differences (SSD), sum of absolute differences (SAD) and the normalized cross correlation (NCC).

Task 2 (4 marks)

Searching through all offsets can become computationally expensive for high resolution images. To speed up the search procedure you can use a so-called image pyramid. An image pyramid is essentially the image at multiple scales, with scales varying by a factor of two. Alignment can then be done sequentially, starting with the highest level and incrementally updating your estimates as you go down the pyramid.

You should first implement an algorithm that can perform reconstruction on low resolution images (Task 1) and only then try to modify your code to handle high resolution images (Task 2). It should be easy to reuse much of the code.

Task 3 (2 marks)

Try to improve the visual quality of the results of the basic algorithm. Some possibilities include colour and contrast adjustments, using a more sophisticated alignment procedure and automatically removing borders.

Hint: For Task 3, you will need to choose images from the Library of Congress collection that best demonstrate your enhancements.

This assignment is worth 10% of the course total. Tasks 1, 2 and 3 must be completed to complete the assignment and will be marked against the maximum mark achievable.

Deliverables: **You should submit a short report (up to 5 pages MAXIMUM) along with your python code**. This report should briefly explain the approach you have taken to align colour channels for Task 1, the modifications you performed to deal with high resolution images in Task 2, and the adjustments you made for Task 3. You may also include details of any enhancements you have implemented. Include results for at least two (2) of the provided high-resolution negatives.

The instructions for uploading the report will be released before the submission date.

21 February 2020